An Issue between Contemporary Theory and Modern Compositional Practice

A Study of Joseph Straus's Laws of Atonal Voice Leading and Harmony using Webern's Opus 12/2 and Crawford's String Quartet Mvt. 3

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Abstract: In his recent research project, music theorist Joseph Straus extends the traditional notions of smooth voice leading and the quality of harmony in tonal music to describe atonal voice leading and harmony. To achieve this goal, Straus proposes a theory called fuzzy transformations to analyze atonal music. Based on his findings, he further concludes the law of atonal voice leading and that of atonal harmony, which state that compositions, especially those in "more conservative styles," do obey these two laws. To test the validity of Straus's laws, I use Crawford's String Quartet Mvt. 3 and Webern's song op. 12/2 as case studies, examining the potential strengths and inherent weaknesses in Straus's fuzzy transformations, and further pointing out a conflict between music theory and compositional practice.

Keywords: voice-leading, fuzzy transformations, atonal harmony.

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In tonal music, most harmonies consist of three to four pitches and are categorized as either triads or seventh chords, a categorization based on an intervallic structure generated by thirds.[2] In atonal music, a harmony can contain any number of pitches and is no longer restricted to a particular intervallic structure. However, this new structural complexity of atonal harmony creates two inherent problems that challenge how we understand an atonal harmonic progression. First, how can discrete harmonies be defined and articulated? Second, how can these harmonies be coherently connected? That is, what are the new criteria for voice leading?

Considering these problems, Joseph Straus proposes the theory of *fuzzy transformations* (1997, 2003, and 2005b), which rely on the traditional notions of smooth voice leading (i.e., a voice moves by the smallest possible step or leap) and the quality of a harmony (chromatic and unchromatic) to define the harmony and voice leading in atonal music.[3] Based on his research and music analyses, Straus concludes the *law of atonal voice leading* and that of *atonal harmony* (2005b, 83–84).[4] He believes that among the diverse styles of atonal music, "especially more conservative styles" (2005b, 84), the harmony and voice leading do obey his two laws. Like a harmonic progression in tonal music, the atonal harmonic

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[3] In Straus's discussion, he argues that his concept of smooth atonal voice leading reflects and recapitulates Schönberg's "law of the shortest way" in tonal music. Schönberg's law defines the tonal voice leading as only existing when "absolutely necessary for connecting the chords" (Schönberg 1978, 39). That is, a voice will only move if it ever needs to. With that said, when a voice does move, it will always choose the smallest possible path, producing a smooth quality.

Like Schönberg's law, Straus uses his fuzzy transformations to examine smooth voice leading in atonal music. His theoretical premise is that the majority of pitches in an atonal chord transpose or inverse the same number of semitones to those in another chord, while the remaining pitches are related by the smallest possible *offset number*. (This will become clearer once I explain Straus's methodology in the text.) Importantly, Straus suggests that this smallest offset number accommodates what he refers to as the "small voice-leading distance," which interprets "disjunct [musical] surfaces with respect to relatively smooth underlying norms." (Straus 2005b, 65–66). By this definition, a voice in atonal music also moves by the least effort, producing a smooth voice that is not unlike Schönberg's law.

[4] The following summarizes Straus's analyses on passages from different compositions. They are categorized by his 1997, 2003, and 2005b articles. The first two articles are voice-leading analyses, and the last one contains both voice-leading and harmonic analyses. Straus's choices of music examples encompass a great diversity in terms of traditions (American, Russian, German, and French) and genres (string quartet, solo piano piece, song, and so forth), which represent a variety of distinct atonal music styles.

The 1997 article includes Roslavets's *Piano Piece*, Schönberg's *Erwartung* and Piano Piece op.11/1, A. Beach's String Quartet Mvt. 1, Webern's *Movements from String Quartet* op. 5/2–3, *Bagatelles for String Quartet* op. 9/5, and "*Die Sonne*" from *Six Songs* op. 14/1, Jolivet's "*Danse initiatique*" from *Cinq danses rituelles*, Stravinsky's "The Soldier's March" from *A Soldier's Tale*, "Introduction" from *Rite of Spring*, *Agon*, *Pieces for String Quartet* nos. 2 and 3, *The Rake's Progress*, "*Bay-bay*" from *Berceuses du chant*, *Concerto for Piano and Wind Instruments* Mvt. 1, and *Orpheus*, Crawford's Chant no. 2, Prelude no. 9, and *Diaphonic Suite* no. 2 Mvt. 3, and Scriabin's Prelude op. 74/4.

The 2003 article includes Weberns's *Movements for String Quartet* op. 5/2 and 5, *Pieces for Violin and Piano* op. 7/1, and *Three Little Pieces for Cello and Piano* op. 11/3, Ravel's "*Forlane*" from *Le Tombeau de Couperin*, Stravinsky's *Concerto for Piano and Winds* mvt. 1 and *Pieces for String Quartet* no.3, Schönberg's *Little Piano Piece* op. 19/2 and *Piano Piece* op. 11/1 and 2, Crawford's Violin Sonata Mvt. 1 and *Diaphonic Suite* no. 4 Mvt. 3, and Sessions's Piano Sonata Mvt. 1.

The 2005b article includes Weberns's *Six Pieces for Orchestra* op. 6/1 and *Movements for String Quartet* op. 5/5, Crawford's Violin Sonata Mvt. 1, Schönberg's *Five Orchestral Pieces* op. 16/1 and *Piano Pieces* op. 11/1–2, Ruggles's *Lilacs*, Sessions's Piano Sonata Mvt. 1, and Stravinsky's *Threni*.

progression tends to move toward and then away from the relatively chromatic harmonies, in which pitches in one chord always flow to those in another chord via the minimal and shortest distances.

To test Straus's laws of atonal harmony and atonal voice leading, this paper analyzes the first section in the second song "*Die Geheimnisvolle Flöte*" (mm. 1–7) from Anton Webern's *Vier Lieder: für Gesang und Klavier*, op. 12/2 (1915–17). While Straus's techniques do reveal some important aspects of voice leading and harmonic progression in Webern's atonal style work, in some textures they nonetheless seem problematic and musically misleading. My findings clearly suggest that Straus's law of atonal harmony applies only when the complete texture, piano plus voice, is analyzed. That is, the structure articulated by the accompaniment alone is negated and contradicted when the voice introduces pitch classes (*pcs*) that do not appear in the accompaniment; in fact, in this section the piano does not repeat simultaneously any pitches appearing in the vocal line. My analysis may point towards a weakness in Straus's theories; but I believe it verifies a unique feature of Webern's atonal lieder: that each pitch of a structural sonority can carry equal – if not competing – voice-leading integrity. It is a theory requiring further development in the future. In addition to Webern's song, a ten-measure passage from Ruth Crawford's String Quartet Mvt. 3 (1931) will be discussed as well while introducing Straus's fuzzy transformations.

JOSEPH STRAUS: FUZZY TRANSFORMATIONS

Before analyzing Webern's song, I must first introduce how Straus applies fuzzy transformations to analyze atonal voice leading, and then explain how he extends this theory to measure the quality of an atonal harmony. Straus's discussion of his fuzzy transformations appears in three different articles, "Voice Leading in Atonal Music" (1997), "Uniformity, Balance, and Smoothness in Atonal Voice Leading" (2003), and "Voice Leading in Set-Class Space" (2005b).[5] While the first two show how Straus develops and shapes his concept of fuzzy transformations in analyzing atonal voice leading, the last one shows how he continues to refine this concept to accommodate atonal harmony. To be more consistent with Straus's terms and methods, the following discussion focuses on his most recent publication.

[5] In addition to these three articles, Straus also briefly discusses this theory in his textbook *Introduction to Post-Tonal Theory* (2005a, 107–12).

The Law of Atonal Voice Leading

Straus asserts that there exists a fuzzy transformational voice leading space between two different set classes (*scs*).[6] He uses the term *maximally uniform* to indicate the quality of fuzzy transposition and *maximally balanced* to signify that of fuzzy inversion (2005b, 45–50). The principle of Straus's method is to transform the greatest number of pitches in one chord (i.e., the largest cardinality of the subset) onto their correspondents in the next by the same semitonal distance, while the remaining pitches are related by a dissimilar one. The difference of these two distances results in an *offset number* (in mod 12, usually marked with parentheses). However, it is possible that there will be several fuzzy transformations, at the same time, all relating the greatest number of pitches in the adjacent chords. We must determine which one is preferable to the others. Straus, then, suggests comparing their offset numbers. He chooses the smallest one, which he calls the *minimal offset number*, to be his ideal candidate. For Straus, this number complements the most uniform or balanced quality and can create a sense of parsimony between adjacent chords. Thus, Straus's *fuzzy transformational voice leading* simultaneously accommodates *parsimonious voice leading space for scs* (2005b, 50).

To make Straus's method more accessible, I use two tetrachords from a passage in Ruth Crawford's String Quartet Mvt. 3 (1931) as an example, showing how to measure the offset number by using the fuzzy transformations. For most of the parts in this movement, each instrument plays a single and different pitch. A succession of four different simultaneous pitches, then, creates a progression of tetrachords. The passage I select contains ten measures, from m. 20 (in which the first full tetrachord enters in this movement) to m. 29 (see Ex. 1). It begins with a *sc* 4-1, which passes through four other *scs* 4-13, 4-12, 4-18, and 4-3 before arriving at another *sc* 4-1 at the end. This creates what we might interpret as an implied tetrachord prolongation of *sc* 4-1. Each pair of the adjacent tetrachords has three

[6] Straus (1997) categorizes contemporary atonal voice-leading theories into three different models. They are *prolongational*, *associational*, and *transformational*. The *associational* uses contextual means (such as instruments, timbres, registers, dynamics, articulations, and pitch contours) to connect the adjacent pitches between successive chords. In a string quartet, for example, we can use instruments as a means to perceive four different instrumental voices.
The *transformational* refers to the application and extension of David Lewin's *Generalized Interval System* (*GIS*), which uses transformation (especially transposition and inversion) to analyze the voice leading between two successive harmonies. The theories that represent this model include Straus's own *fuzzy transformational voice leading* and Henry Klumpenhouwer's *K-net*. (For information about *K-net*, see Klumpenhouwer 1991 and Lewin 1994. For a further elaboration of *K-net*, see Philip Stoecker 2002 and Michael Buchler 2007. In addition, since the topic of this paper focuses on the transformational model, for those who may be interested in a similar approach in analyzing atonal music, I provide some references listing the related researches conducted by current theorists: John Roeder 1984, 1989, and 1995, Robert Morris 1995a, 1995b, and 1998, Richard Cohn 1997 and 2003, Shaun O'Donnell 1997, Ciro Scotto 2003, Michael Siciliano 2005, J. Daniel Jekins 2010, Justin Lundberg 2012, and Joe Argentino 2010 and 2013.)
The *prolongational* model, which "has its roots in the theories of Heinrich Schenker" (Straus 1997, 237), uses graphical notations— such as slurs and stems— to identify structural pitches from the embellishing ones. Scholars whose works feature this model include Roy Travis 1970, James Baker 1990, and Paul Wilson 1984. In addition to categorizing various voice-leading techniques into three different models, Straus also critiques and evaluates these techniques, pointing out their potential weaknesses and practical strengths.

tones in common, and the uncommon ones appear either in the first violin or cello.[7] In this passage, I use two adjacent tetrachords *scs* 4-12 and 4-18 to illustrate Straus's fuzzy transformational voice leading (see Ex. 2). In order to create a clearer image, I use pitch-classes (*pcs*) to represent their corresponding pitches on the score in the following discussion.

Two possible results appear in Ex. 2, fuzzy transposition T_0 (the left sketch) and fuzzy inversion I_3 (the right sketch). Both T_0 and I_3 transform three pitches from *sc* 4-12 to *sc* 4-18, while the offset *pcs* (<4, 11> in the left sketch and <6, 6> in the right) are related by T_7 and I_0, respectively. Thus, the differences between the T-numbers, 7 and 0, in fuzzy transposition and I-numbers, 0 and 3, in fuzzy inversion derive the offset numbers 5 and 3 (marked with parentheses on the bottom of the sketches), respectively. The two tetrachords in the left sketch are maximally uniform, since most of the *pcs* are related by T_0. The right one represents maximally balanced sets; there is only one pair of *pcs* 6 and 6 that are I_0- related, which is different from the other I_3-related pairs.

Both operations T_0 and I_3 in Ex. 2 can map the greatest number of three *pcs* from one chord to the next, producing the maximal uniform or balanced relationship between the two tetrachords. However, the question is which one best moves the *pcs* in the most parsimonious way? Considering this question, we need to compare the difference between the two sketches in Ex. 2. The right one, which is maximally balanced, has a smaller offset number of 3 than that appearing in the left (offset number 5). The comparison between the different offset numbers derives the minimal offset number, 3, which determines the most parsimonious voice leading between the two chords. As a result, fuzzy inversion I_3 with its offset number 3 can produce the most parsimonious voice leading between *scs* 4-12 and 4-18. Importantly, through this example, we understand that Straus's parsimonious voice leading space for *scs* accommodates both smooth voice leading and minimal-offset voice leading between two chords of

7 The reader may notice that voice crossings constantly appear throughout this passage. (Voice crossing here refers to a pair of adjacent string instruments whose registral orderings do not follow the traditional, standard string quartet setting, in which Vln I, Vln II, Vla, and Vc, respectively, project the soprano, alto, tenor, and bass voices.) Ellie Hisama uses the term "degree of twist" to define the number of voice crossing within a chord in this particular movement (1995, 298). For instance, the first tetrachord in Ex. 1, *sc* 4-1, has a degree of twist 2— Vc over Vla and Vln II over Vln I. Based on her analysis of the degree of twist, Hisama discovers multiple climaxes achieved by the gradual progressions moving toward and then away from an exceedingly twisted texture, which do not coincide with the registral and dynamic climax at m. 75. For Hisama, the highly twisted texture represents what she believes to be a "feminist" climax (1995, 305), which is opposed to the register and dynamics representing a more contextual, traditional, and "masculine" form of climax in a composition. (In addition, Edward Gollin [2009] extends Hisama's study by applying a *Cayley graph* to analyze how the registral permutations of the four string instruments create a transformational network, and further uses his results to support Hisama's view of feminist climax in Crawford's String Quartet Mvt. 3.)
Furthermore, Straus 1995 also analyzes the same passage of this movement in terms of its musical contour, and he finds a common contour segment <1 3 0 2> represented in various musical elements of pitch, rhythm, dynamics, register, and instrument. However, despite the fact that these elements delineate the same contour segment, they usually do not coincide with one another. For instance, the pitches in the melodic contour are different from those in the durational contour. This results in a complex relationship among contours formed by different musical elements, which requires an "attentive listening from many directions" (1995, 169).

different *scs*. Straus defines such chords related by the most parsimonious voice leading as the *law of atonal voice leading*.

After learning how Straus's fuzzy transformational voice leading works in analyzing a composition, let us apply it to study the entire passage in Ex. 1. As pointed out earlier, this passage projects an implied harmonic prolongation of *sc* 4-1. However, in addition to the same *sc*, how do we know that the process of prolongation in this passage is complete? Through my observation, I find not only is there a contextual articulation of rhythmic duration, there is also an underlying structural one of voice leading that Crawford uses to reinforce the sense of completeness for this process of prolongation.

Contextually, the last chord of *sc* 4-1 continues for a long duration of four measures. This creates a static, frozen, and stable motion, or a sense of a closure. Meanwhile, Ex. 3 analyzes the fuzzy transformational voice leading of this passage. Like Ex. 2, each tetrachord is translated into a pitch-class set (*pcset*) directly below the musical system. The arrows labeled with T_n or I_n connect the offset *pcs*. The fuzzy transformations and their associate offset numbers are on the bottom of the sketch. An interesting observation derives from the comparison of the five resulting offset numbers <4, 3, 3, 4, 2>. This passage concludes with the smallest offset number of 2, which is proceeded by the relatively larger ones, 3 and 4. An impulse from the larger to the smaller numbers suggests that the passage begins with relatively large moves in *sc* space and then gradually progresses to relative smoothness. The progression towards this smoothness marks a contrast between "tension" and "relaxation." Relatively large moves create a restless and unstable "tension," which can be resolved by the eased and stable "relaxation" formed by relatively small moves. The relationship between tension and relaxation thus mimics a dominant-to-tonic cadence in tonal music, in which the restless dominant chord is resolved by the static tonic chord. Accordingly, the smooth voice leading with the smallest offset number of 2 at the end of the passage eases the earlier tension. Based on the above analysis, we understand how Crawford uses both rhythmic duration and voice leading to support a complete harmonic prolongation of *sc* 4-1.

The Law of Atonal Harmony

In "Voice Leading in Set-Class Space," Straus extends his concept of offset numbers to examine the relatively harmonic qualities among different chords. To explain his method, Straus begins with a simple example measuring the offset numbers of all twelve trichordal *scs* 3-1 to 3-12 in relation to *sc* 3-1 (see Ex. 4). As trichords moving away from *sc* 3-1, their corresponding offset numbers become larger (numbers range from 0 to 6).[8] In addition, Straus claims that "the traditionally dissonant harmonies tend to be the most chromatic ones…[and] the traditionally consonant or stable harmonies are always among the least chromatic (and most even)" (2005b, 73). He believes that these traditional notions of the most and least chromatic harmonies can relate in suggestive ways to the qualities of the twelve trichords in Ex. 4. Comparing the opposing extremes of the *scs*, *sc* 3-1 is the most chromatic set, while the *pcs* in *sc* 3-12 are the most evenly spaced. Thus, these two *scs* 3-1 and 3-12, for Straus, complement the relationship between *dissonance* versus *consonance*, *instability* versus *stability*, and *compactness* versus *evenness* (2005b, 77). Interestingly, gradually moving from the most chromatic *sc* 3-1 to the most even *sc* 3-12, the associated offset numbers also beautifully reflect this progression, moving from the smallest number of 0 to the largest 6. Accordingly, Straus suggests that these numbers can simultaneously accommodate the harmonic qualities of their associated trichords, which are measured in relation to *sc* 3-1. The larger the offset number, the more consonant, even, and spacious the harmony; the reverse is also true – the smaller the offset number, the more dissonant, compact, and chromatic the harmony.[9] To provide a more consistent discussion, hereafter I only use Straus's terms "chromatic" and "even" to define the quality of a harmony.

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[8] The vertical (from top to bottom) and horizontal lines (from left to right) in Ex. 4 connect the *scs* via $T_{0\,(1)}$, while those linked by the diagonal (from northwest to southeast) are $T_{1\,(1)}$-related.

In addition, I must point out that in Straus's discussion, he actually measures all twelve *scs* in relation to *sc* 3-12 as well (see Ex. F-1), and the result is completely contrary to that in Ex. 4. As trichords move away from *sc* 3-12, their corresponding offset numbers become *smaller*. However, comparing the offset numbers in both Exs. 4 and F-1, we notice that while most of *scs* consistently have two complementary offset numbers creating a sum of 6, this consistency does not apply to *scs* 3-5 and 3-9. They have the sum of 7. Straus refers to this inconsistency as "rogues" (2005b, 68). To avoid this problem, Straus only measures *scs* against the most chromatic *sc* after his Fig. 15.

[9] Similarly, based on the same method, Straus also measures all the six dyadic *scs* 2-1 to 2-6 in relation to *sc* 2-1 (see Ex. F-2). Based on Straus's definition of the harmonic qualities, these offset numbers suggest that *scs* 2-1 and 2-6 are, respectively, the most consonant and dissonant dyads. However, two questions beg for study if we further replace these six dyads with their corresponding interval classes (*ics*) 1 and 6. The first is the ambiguous quality of *ic* 6 formed by *sc* 2-6. In the article, Straus acknowledges that this *ic*— the tritone— is "obviously not a traditional consonance," but "the traditionally most consonant dyad, 2-5 [i.e., *ic* 5], is only one degree of offset away" (2005b, 73). Here, *ic* 6 bears a conflicting definition. Theoretically, it has the largest offset number, which seems to imply the notion that the tritone is not only a consonant interval but also *the most* consonant one. Practically, however, it is not even a consonance. In this sense, the premise of "the larger the offset number, the more consonant the *sc*" becomes less convincing and legitimate. (In fact, the quality of the tritone in post-tonal music has been challenged by many scholars, who have debated this issue and attempted to seek a theoretically convincing way to define the tritone as either a consonance or dissonance. For instance, Charles Seeger hears it sound "more consonant chordally than melodically" [1994, 40]; Ernst Krenek assumes that its "character of a consonance or of a dissonance depends on the third tone added" [1940, 20]; and Paul Hindemith, even more puzzlingly, argues the tritone to be a "dissonance" but not "cacophony" [1984, 85]. The above three examples juxtapose contrasting interpretations concerning the quality of the tritone and reveal representative kinds of disagreements about this particular interval among post-tonal composers.)

The second question concerns the absence of *ic* 0 in Ex. F-2, which represents both the octave and unison. If we were to consider this *ic* as well, what would the result be? (In Straus's article, he also measures the offset numbers of *scs* with different cardinalities. For instance, his Fig. 17 measures all the trichordal and tetrachordal *scs* against *sc* 3-1. Following the same concept, we can then add the singleton *sc* 1-1 in my Ex. F-2 and measure all the six dyadic *scs* in relation to it.) Would the result still place the *ic* 6 as the most consonant interval? If so, wouldn't this essentially conflict with the fact that the octave has always been considered to be the most perfect and consonant interval? If not, would *ic* 6 still represent a consonance?

Based on his definition of the quality of a harmony, Straus further proposes the *law of atonal harmony*. His law states that atonal music, "especially more conservative styles" (2005b, 84), generally does obey this law, for its harmonic progression begins and ends on relatively even harmonies, reserving the most chromatic ones for points of relative tension. In this sense, Straus beautifully aligns atonal music with the tonal tradition, for both musical styles tend to prolong the stable motion created by the relatively even harmony, which is embellished by the momentary tension produced by the most chromatic harmony. To test the validity of Straus's law, let us use Ex. 1 again as a practice, observing whether or not Crawford's String Quartet conforms to Straus's law of atonal harmony, representing what he refers to as a " more conservative style" of atonal music.

For the sake of discussion, I use Straus's Fig. 16 as a reference to measure the offset numbers of all the tetrachords in Ex. 1. His figure is reproduced in my Ex. 5. Based on this example, the offset numbers of the six tetrachords are 0, 4, 3, 6, 2, and 0 (see Ex. 6). This result strikingly contradicts Straus's law, for it actually begins and ends with the most chromatic *scs* 4-1 having the smallest offset number 0s, reserving the most even *sc* 4-18 having the largest offset number 6 at the middle of the progression. Since the entire progression is framed by the most chromatic harmony, this passage maintains a tense and unstable motion, in which the most even harmony only appears momentarily to embellish, not to resolve, the unceasing tension. Additionally, this result becomes much more intriguing and thought provoking if we further consider it along with my earlier voice-leading analysis in Ex. 3. While Crawford uses both long durational rhythm and the smoothest voice leading at the end of the passage to create a sense of relaxation that supports the closure of the harmonic prolongation of *sc* 4-1, her usage of the harmonic quality, on the contrary, projects an utterly conflicting effect, for the overall harmonic progression holds an unresolved tension. Thus, as the quartet progresses to m. 29, it simultaneously juxtaposes the two contrary effects. They co-exist side-by-side, producing a dynamic force created by the confrontation among harmony, voice leading, and rhythmic duration.

Furthermore, based on the analysis of Ex. 6, I also suspect that Crawford intentionally writes what Straus might interpret as "a less conservative style of harmonic progression," which allows her String Quartet to distinctively stand out from the majority of the atonal repertoires. But what is Crawford's intention in writing such a less conservative style of harmonic progression? Does it represent her ideal type of atonal sound? If so, how would she critique those works that stay in the mainstream of a "more conservative style" of atonal music? Meanwhile, if Crawford favors this type of sound, does my analysis reveal and represent her personal signature of harmonic language, which appears in all her compositions? If not, is this String Quartet only a special and experimental case? Although Exs. 3 and 6 are short analyses of Crawford's atonal voice leading and atonal harmony, the outgrowing questions derived from these two analyses, nevertheless, show some clear leads and directions for the theorist who is interested in a further study of her unique compositional crafts.

The above discussion has thoroughly introduced and explained how Straus's fuzzy transformations work in analyzing both atonal voice leading and atonal harmony in a composition. Next, I will apply his method to study the first section in the second song "*Die Geheimnisvolle Flöte*" from Webern's op. 12. Through this analysis, I will demonstrate the potential strengths and inherent weaknesses in Straus's method, which further illuminate a conflict between music theory and compositional practice.

WEBERN, "DIE GEHEIMNISVOLLE FLÖTE," OPUS 12/2 (1917)

Ex. 7 presents the initial seven measures from Webern's song "*Die Geheimnisvolle Flöte*". It is written for a soprano with the piano accompaniment. This section includes a two-measure piano prelude (mm. 1–2) followed by the soprano's first three phrases covering the first line of the poem (mm. 3–7).[10] The harmonic segmentation is shown in Ex. 8. To add clarity to my segmentation, all the slurs and the text are removed in this example. Before any further discussion, I must first explain my method of harmonic segmentation.

The criterion in which I ground my method is musical texture. While most of the segments in Ex. 8 are either straightforward vertical chords (such as the three *sc* 5-21s in m. 2) or short melodic figures supported by light chordal accompaniments (such as *scs* 5-Z38 and 7-30 in m. 1), those from the second half of m. 4 to the end of m. 5 are small melodic fragments distributed among the three staves (except for *sc* 3-8 in m. 5, which is on the left hand of the piano).[11] Thus, my segmentation reveals two types of texture in Ex. 8. The former reflects the part of homophonic texture, and the latter reflects that of the polyphonic.[12] In addition, based on this segmentation, I divide Ex. 8 into two parts indicated

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[10] The poem "*Die Geheimnisvolle Flöte*" ("春夜洛城聞笛") is written by the Chinese poet Tai-Po Li (A.D. 701–762), which contains four lines featuring the structure and style of the poetry of the Tang Dynasty (A.D. 618–907). Webern's choice of this poem is based on Hans Bethge's German translation. Since my topic is Straus's fuzzy transformational voice leading and harmony, the relationship between the text and music will be left relatively unexplored. For those who are interested in this subject matter, see my own work 2007 and Eric Hogrefe 2011.

[11] The trichord, *sc* 3-1 in m. 3, along with the three transpositionally related pentachords, *sc* 5-21s in m. 2, form an eleven-note aggregate. (The order of the three *pcs* in m.3 respectively originates from the order of the preceding three *sc* 5-21s, except *pc* 6 appears twice in the first and second *sc* 5-21.) The only missing *pc* 11 appears in m. 4, the first dotted quarter note in the vocal line, at which point the soprano starts to join the segmentation with the piano accompaniment. Therefore, the trichord in m. 3 is not identified as a single harmonic set, but rather it connects the piano prelude with the entrance of the soprano.

[12] Allen Forte 1998 defines the three consecutive *sc* 5-21s in m. 2 as forming a unique ordered set of *pcs* (see Ex. F-3) called the "magic rectangle" (1998, 261), and he discovers that Webern's selections of harmonies in this song are primarily subsets derived from this rectangle. For instance, Ex. F-4 reproduces Forte's Ex. 11.8 (1998, 266), which demonstrates that the *pcs* of the final chord in this song (mm. 26–28) are those exactly appearing in the cross-shape box in Forte's magic rectangle (see Ex. F-4b).

by the circled capital Roman numerals I and II on the score. Part I contains the piano prelude (mm. 1–2), and Part II marks the entrance of the voice till the end of this section (mm. 3–7). Part I is composed of a chordal progression moving from *scs* 5-Z38, 7-30, to three 5-21s. Similarly, Part II also begins with a brief chordal progression in m. 4, which contains two pentachords *scs* 5-6 and 5-14. However, it immediately separates into two progressions A and B that cross each other at the beginning and run through the middle of this part (the arrows on the score track these two progressions). Progression A (marked with dashed arrows) contains a series of three tetrachords: from *scs* 4-6 (voice), 4-18, to 4-16 (piano, right hand). Progression B (marked with solid arrows) contains a series of four trichords: from *scs* 3-5, 3-8 (piano, left hand), 3-5, to 3-5 (voice). Finally, these two progressions merge at *sc* 6-Z17 in m. 6, which is followed by a *sc* 7-Z38 – the complementary chord of the initial *sc* 5-Z38 in m. 1.

Ex. 9 shows the details of fuzzy transformational voice leading in this section. Again, like Crawford's String Quartet, the dashed lines link the pairs of offset *pcs* between two successive chords. For the sake of discussion, I simplify the image of Ex. 9 by using a diagram format to represent all the *scs* and the offset numbers that outline the overall progression of voice leading (see Ex. 10). I call this new example the foreground diagram of voice leading. According to this example, the offset numbers range from 0 to 4. Within this range, I define offset numbers 0 and 1 as representing relatively smooth voice leadings, and offset numbers 3 and 4 as relatively disjunct voice leadings.

The foreground diagram of voice leading in Ex. 10 shows that Part I begins with relatively large moves in *sc* space and then gradually progress to relatively small moves (see the first four offset numbers, 3–3–0–0). Part II is slightly different from Part I, for it both begins and ends with a relatively smooth voice leading based on its offset numbers 1 (between *scs* 5-6 and 5-14) and 1 (between *scs* 6-Z17 and 7-Z38), respectively. In addition, notice that just right before the last offset number 1 appears the two most disjunct voice leadings in Ex. 10, which are in the process of merging from the two progressions A and B to *sc* 6-Z17 – offset number 4 between *scs* 3-5 and 6-Z17, and offset number 3 between *scs* 4-16 and 6-Z17. The large contrasts among these three offset numbers at the end of this section create an impulse analogous to the dominant-to-tonic cadence in tonal music defined earlier during my discussion of Crawford's String Quartet (see Ex. 3). Consequently, I discover that Webern, like Crawford, also uses a relatively smooth voice leading to conclude the entire section.

In terms of the voice leading from a broader perspective, I study it between the boundary chords (i.e., the initial and the final ones) in each part (see Ex. 11). Part I contains the first *sc* 5-Z38 in m. 1 and the last *sc* 5-21 in m. 2. Part II is a little more complex than Part I. The first *sc* 5-6 is connected with the last chords in both progressions A (*sc* 4-16) and B (*sc* 3-5), which merge again at *sc* 6-Z17 followed by a *sc* 7-38. I call this progression the middle-ground diagram of voice leading. In this example, except for the two big leaps in the process of merging from progressions A and B to *sc* 6-Z17, the other voice leadings all are relatively smooth moves with offset numbers of either 1 or 2. Another interesting observation in this middle-ground progression is that all the chords move by fuzzy transposition. On the other hand, the background diagram of voice leading shown in Ex. 12 reveals that the initial pentachord, *sc* 5-Z38, finally progresses to its complementary septachord, *sc* 7-Z38, via fuzzy inversion. As a result, in terms of the large-scale voice leading of the whole section, the two maximally uniform Parts I and II underlie and articulate the overall maximally balanced structure.

After the study of voice leading, let us examine whether or not Webern obeys Straus's law of atonal harmony to arrange his chromatic and even chords. I measure all the chords in Ex. 8 in relation to *sc* 5-1 (since the cardinality of a chord in this section ranges from three to seven *pcs*, I choose the one with the mediate cardinality of five *pcs* as my measuring reference – i.e., *sc* 5-1). Meanwhile, in order to represent my result in a more tangible way that mimics the flow of harmonies, I use a graph format to illustrate the relative degree of chromaticness of each chord (see Graph 1).[13] Here, the resultant offset numbers range from 4 to 10. Within this range, I define the smallest three offset numbers 4–6 as representing the chromatic harmonies, and the largest three offset numbers 8–10 as the even ones.

Based on Graph 1, the most even chord, *sc* 7-30, appears at the beginning of the section, just after the initial pentachord *sc* 5-Z38. The harmonic progression then moves to and stays at the lower range of the graph for a long period of time (from the first *sc* 5-21 all the way to both *scs* 4-16 and 3-5 located at the third to the last position in this graph), creating a succession of chromatic chords spanning from the second half of Part I through most of of Part II (their offset numbers are all within the smallest range between 4 and 6). Finally, the last two chords in Part II return to the higher range of the graph with the two offset number 8s, which correspond to the two even harmonies. Importantly, if we look at the overall picture of this graph, we notice that Webern's arrangement of chromatic and even chords exactly conforms to Straus's law of atonal harmony, for it begins and ends with the even chords, reserving the most chromatic ones at the middle. With this analysis considered, Webern's "*Die Geheimnisvolle Flöte*," as contrary to Crawford's String Quartet analyzed in Ex. 6, then perfectly fits into the category of the "more conservative style" of atonal music defined by Straus.

The above analyses have examined the voice leading and the quality of harmony under the context of the complete texture in Webern's song – that is, the voice and piano together. In tonal music, piano accompaniments are almost always supportive harmonically and contrapuntally to solo voices or solo instruments. Accompaniments unfold progressions not only of vertical harmonies but also of horizontal lines. Consequently, a tonal piano accompaniment in itself accommodates or implies

[13] Here, instead of a more conventional term "chromaticism," my discussion follows Straus's "chromaticness" used in his 2005b article.

coherent voice leading. Daniel Harrison (1994) mentions the relationships between accompaniments and voice leading in his *Harmonic Function in Chromatic Music*:

> The creation of normative accompaniments is motivated by the same spirit that has animated other recent models of tonal motion that treat voice-leading events as creatures of harmony. These models are powered by analytic engines that take in a harmonic and voice-leading progression from a composition and return a reduced and abstract chordal version whose voice-leading bears little resemblance to that of the input; such a routine highlights pure harmonic forces at the expense of voice-leading forces, offering an undiluted expression of the harmonic content of a passage (1994, 102–03)

Here, Harrison marks the important point about how a tonal piano accompaniment dominates the implied harmonic and voice-leading progressions. In relation to my analyses, one question that must be asked regarding Harrison's statement is: does the piano accompaniment alone in Webern's song, which represents one of his major compositions of atonal music, also have the ability to project the implied voice-leading and harmonic progressions? Prompted by this question, I continue to examine the harmony and voice leading in the piano part, and then compare my result with the earlier analyses.

Exs. 13 and 14, respectively, present the harmonic segmentations and foreground diagram of voice leading in the piano part. Graph 2 shows the degrees of chromaticness of all the chords. If we compare the voice leading analysis between Exs. 10 and 14, we notice a crucial difference appearing at the end of the progression between these two examples. In Ex. 14, both progressions A and B smoothly merge at the last *sc* 3-8 – smoothly in a sense that their offset numbers (1 between *scs* 4-16 and 3-8, and 0 between *scs* 3-8 and 3-8) are still smaller than the one between the last two chords in this song (2 between *scs* 3-8 and 5-7). Thus, the most disjunct voice leadings at the same place in Ex. 10 no longer exist. More importantly, this observation also points out that the quasi dominant-to-tonic cadence appearing in Ex. 10 now is missing in the piano part. Next, let us compare the harmonic progression in Graphs 1 and 2. Notice that both harmonic progressions in these two graphs begin with a chord that is located at the highest range of the graph and then move to and stay at the lower range for a long period of time. However, while the progression in Graph 1 eventually returns to the higher range, that in Graph 2 never rises again. Instead, it remains at the same place, which is at the lowest range (offset numbers 4–6) of Graph 2. Accordingly, this result conforms neither to Straus's law of atonal harmony nor his so-called "more conservative style" of atonal music. In conclusion, the harmonic progression of the piano part alone is not compatible with that projected with the inclusion of the vocal line. It actually contrasts with the harmony and voice leading of the complete texture.

Straus brings important traditional tonal concepts of voice leading and harmonic progression to the world of atonal music. But as my analyses suggest, an important dissimilarity exists between traditional tonal songs and this particular atonal song. In the tonal songs, the piano part almost always unfolds a coherent voice leading and harmonic progression; in this song, however, the vocal line is essential to projecting coherent harmonic progression of the sort defined by Straus. Is the unique structure of this section just a single case in atonal song literature? Or does it illustrate a common feature? If the latter is the case, does an accompaniment in an atonal context impose a new relationship to solo voices? Answering these questions will require the further study of many other atonal songs and instrumental repertoires.

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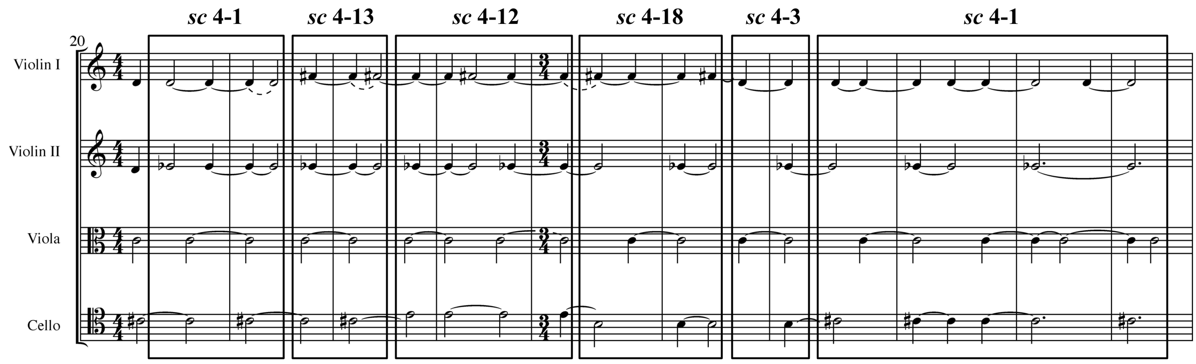
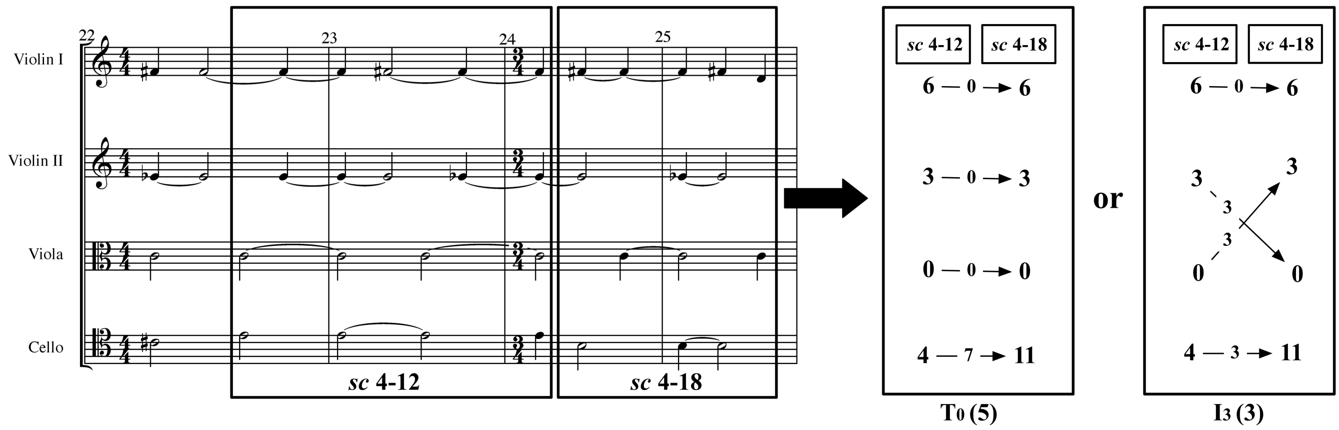
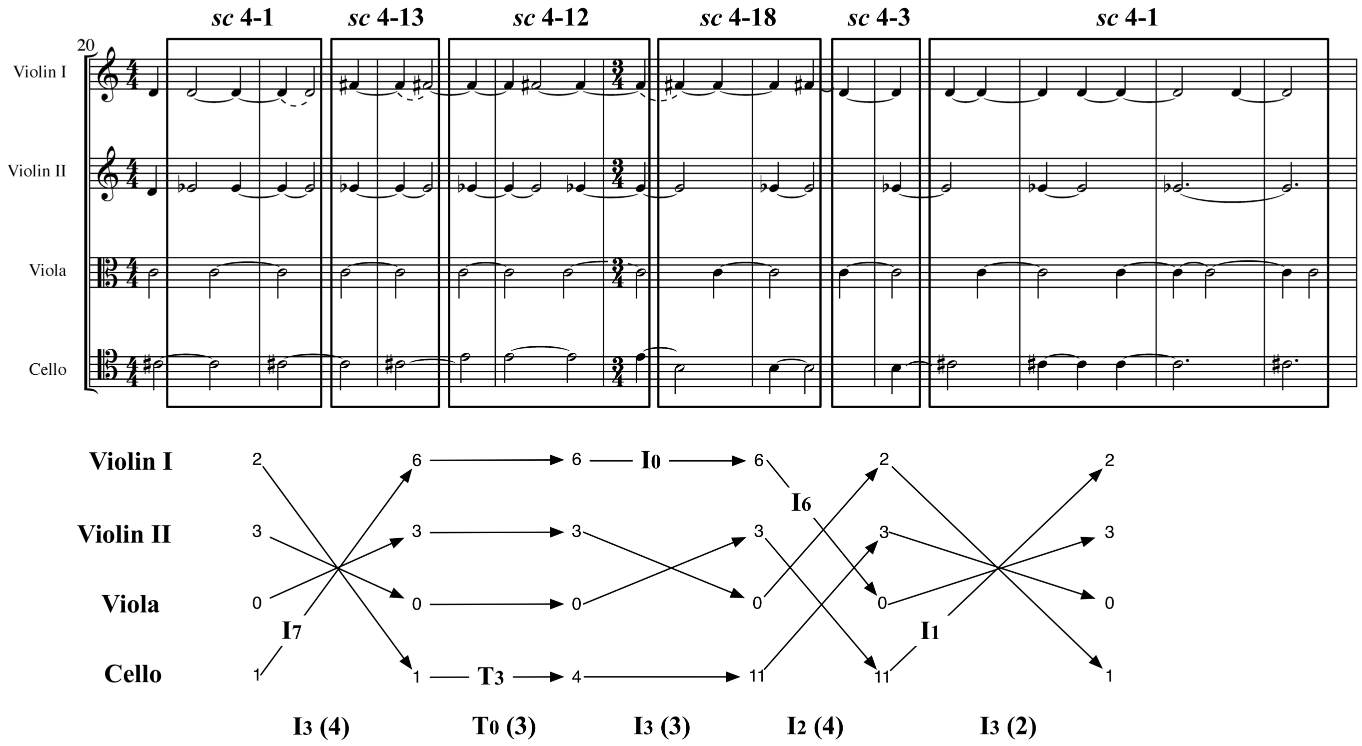


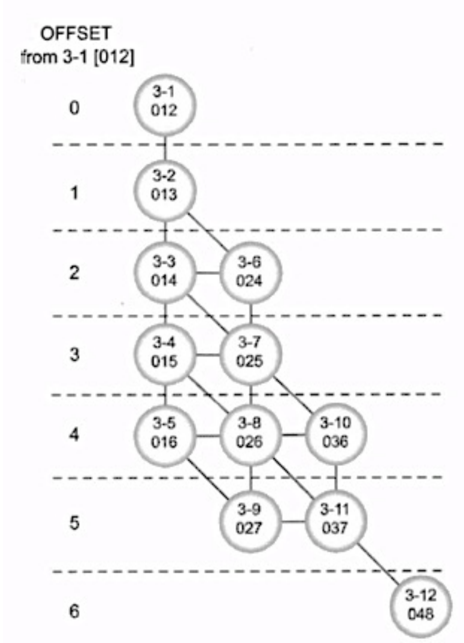
Ex. 1 Crawford, String Quartet Mvt. 3, mm. 20–29



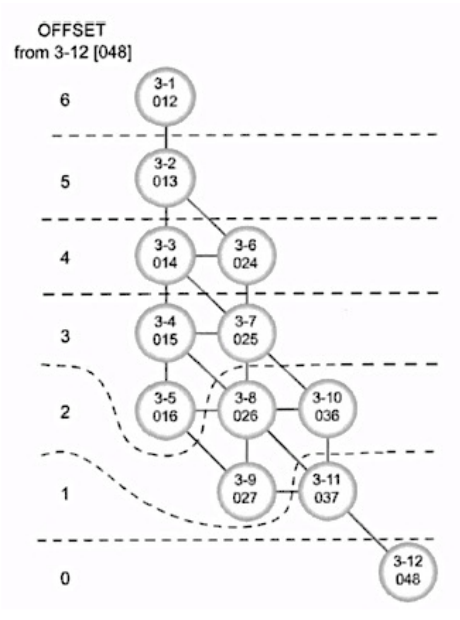
Ex. 2 Crawford, String Quartet Mvt. 3, mm. 22–25;
Straus's fuzzy transformational voice leading between *scs* 4-12 and 4-18



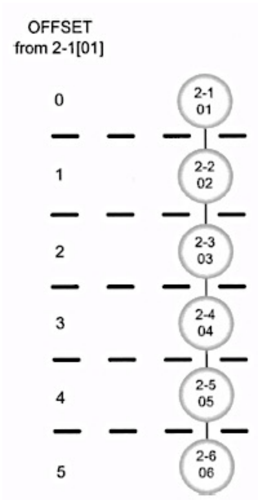
Ex. 3 Crawford, String Quartet Mvt. 3, mm. 20–29;
Straus's fuzzy transformational voice leading (parsimonious voice leading)



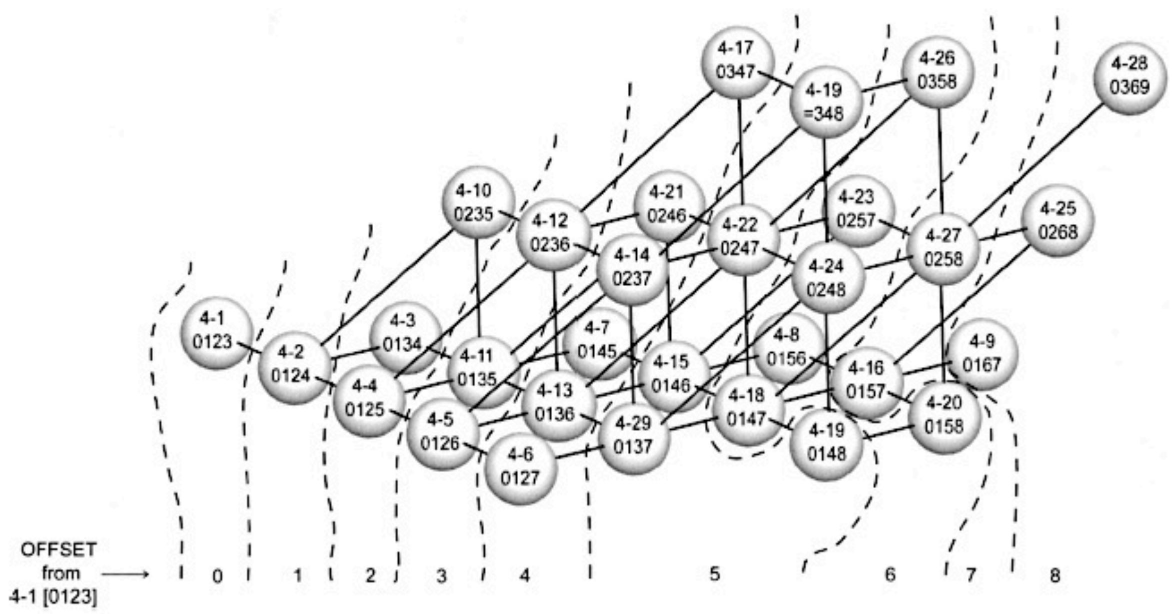
Ex. 4 Measuring the offset numbers of *scs* 3-1 to 3-12 in relation to *sc* 3-1 (Straus 2005b, 69)



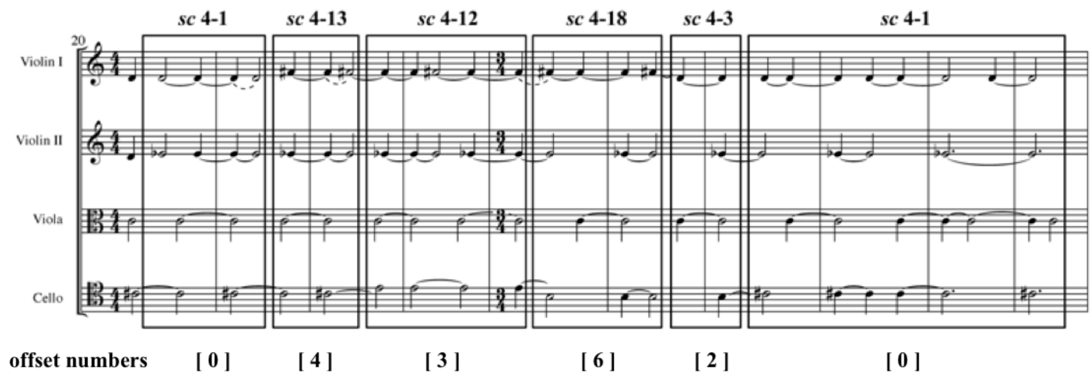
Ex. F-1 Measuring the offset numbers of *scs* 3-1 to 3-12 in relation to 3-12 (Straus 2005b, 69)



Ex. F-2 Measuring the offset numbers of scs 2-1 to 2-6 in relation to 2-6
(Straus 2005b, 68)

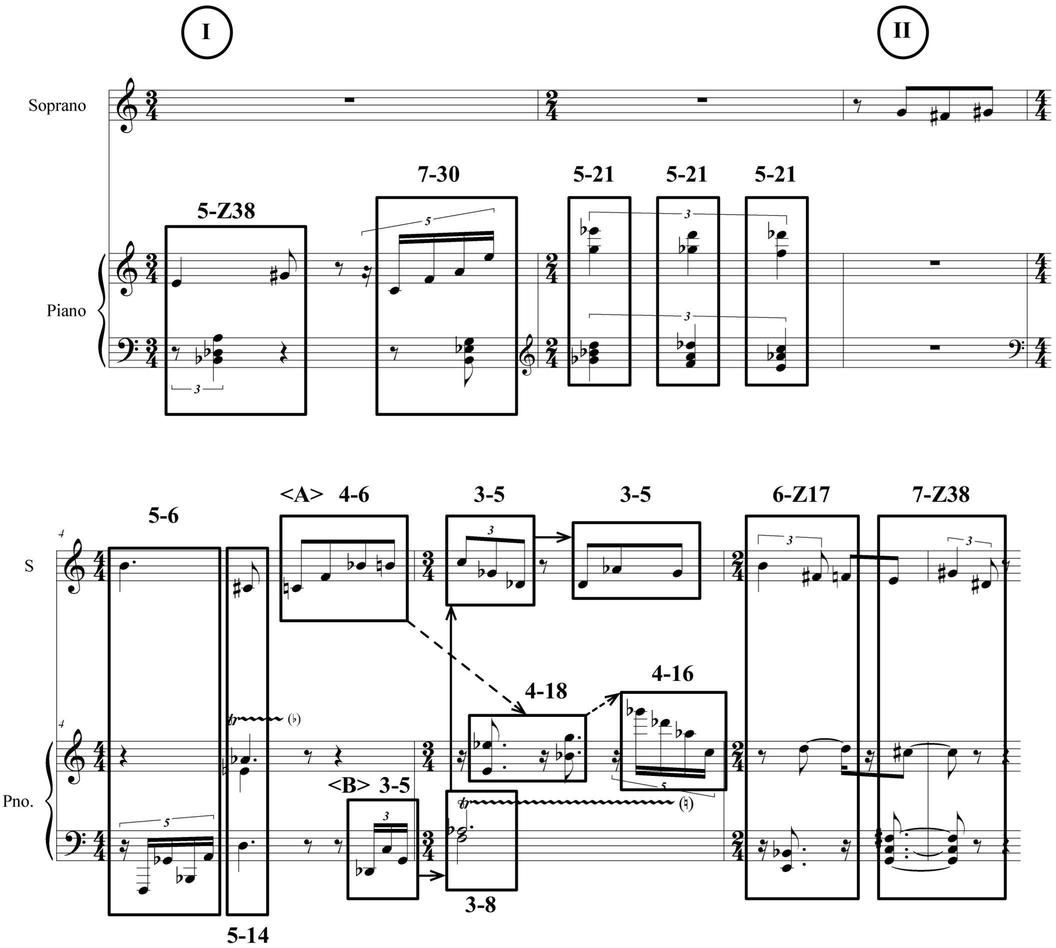


Ex. 5 Measuring the offset numbers of *scs* 4-1 to 4-28 in relation to *sc* 4-1
(Straus 2005b, 70)



Ex. 6 Crawford, String Quartet Mvt. 3, mm. 20–29;
offset numbers of the six tetrachords

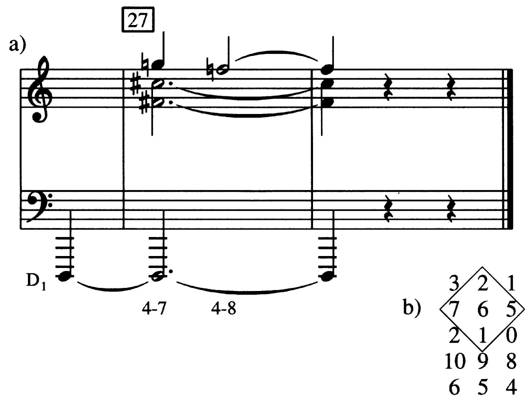
Ex. 7 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7



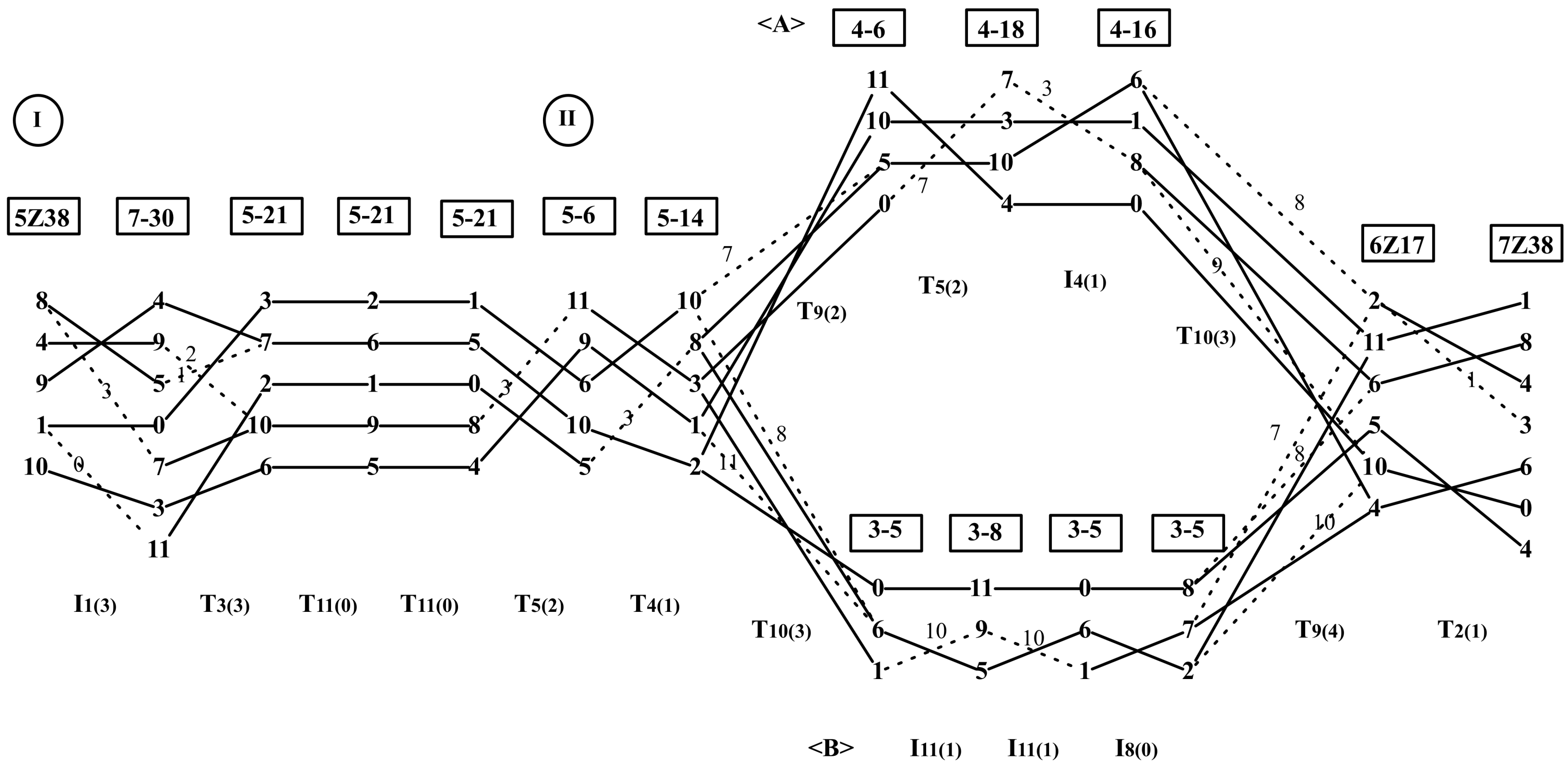
Ex. 8 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7; harmonic segmentations

E♭ D D♭	=	3 2 1
G B♭ F	=	7 6 5
D D♭ C	=	2 1 0
B♭ A Ab	=	10 9 8
G♭ F E	=	6 5 4

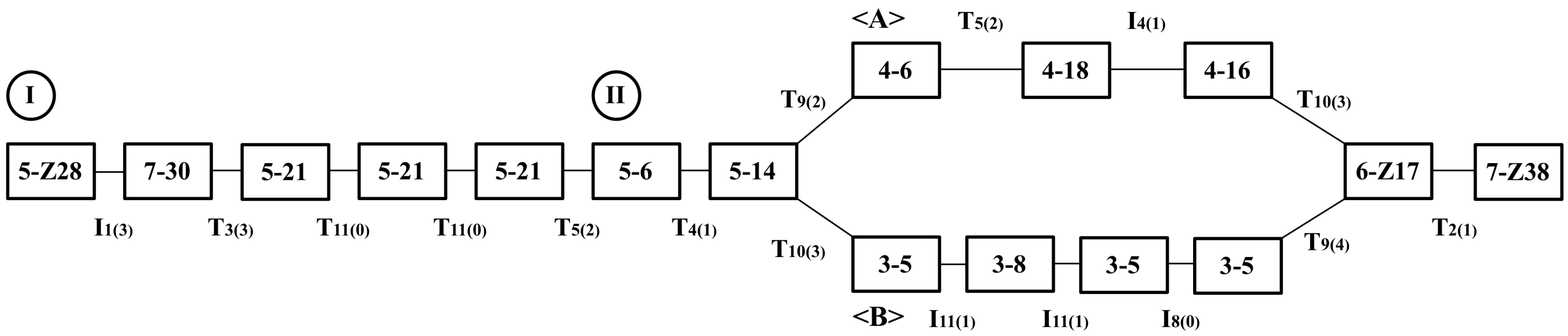
Ex. F-3 Forte's magic rectangle (1998, 261)



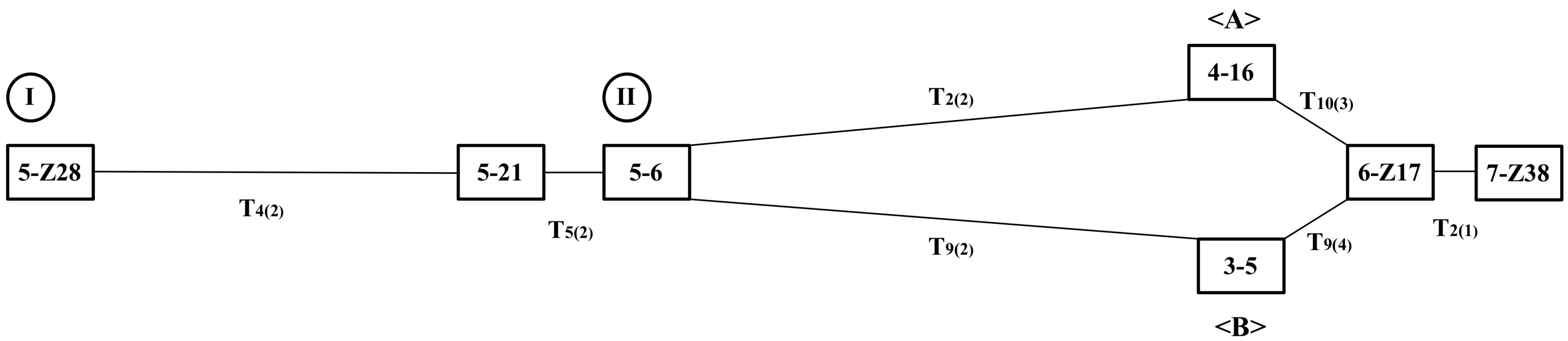
Ex. F-4 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 26–28
(Forte 1998, 266)



Ex. 9 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7;
analysis of fuzzy transformational voice leading (dashed lines connect the offset *pcs*)

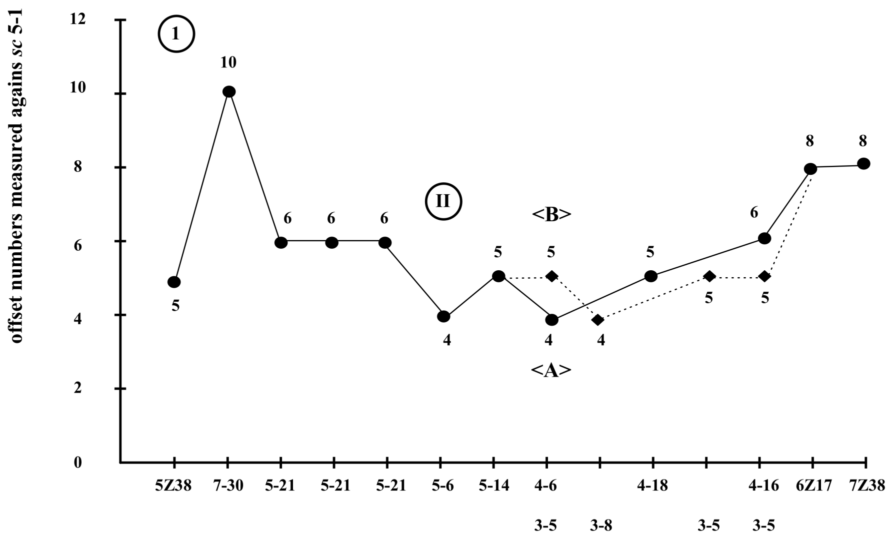


Ex. 10 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7;
the foreground diagram of voice leading

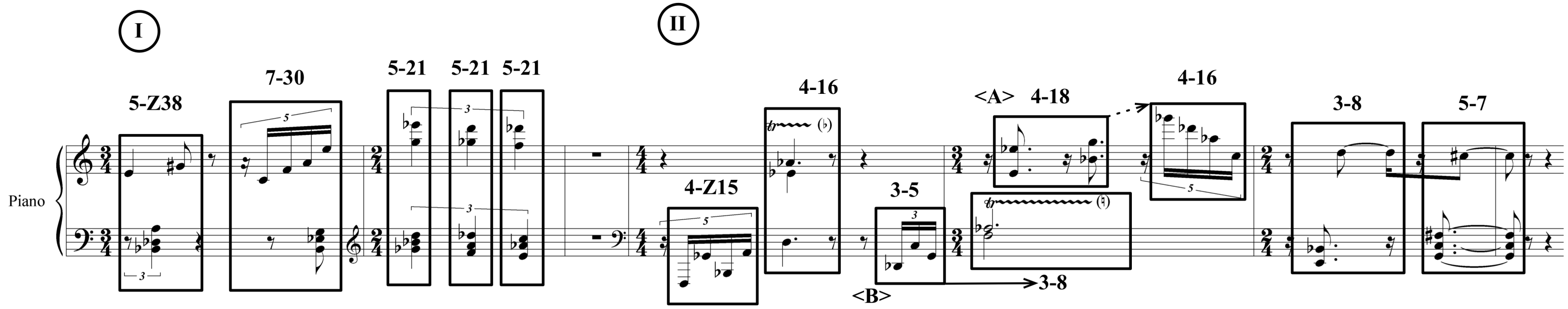


Ex. 11 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7;
the middle-ground diagram of voice leading

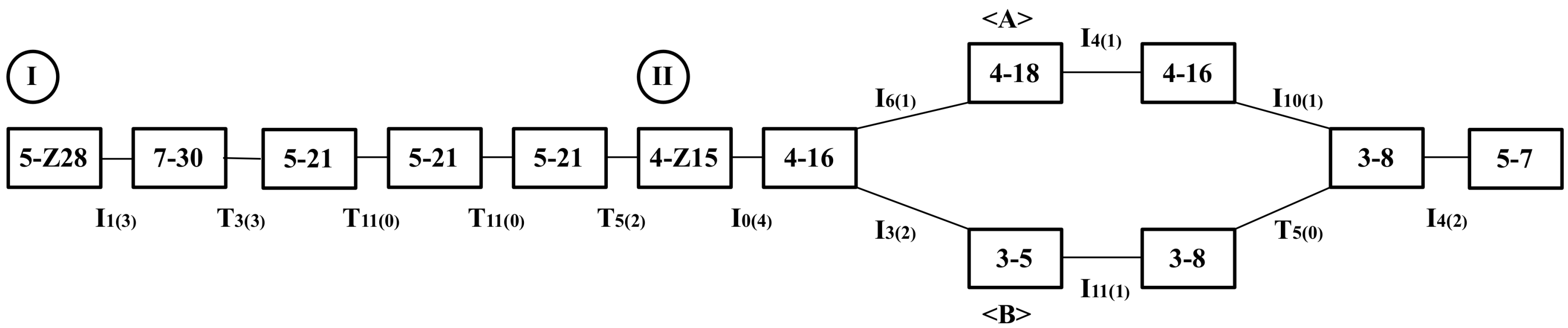
Ex. 12 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7;
the background diagram of voice leading



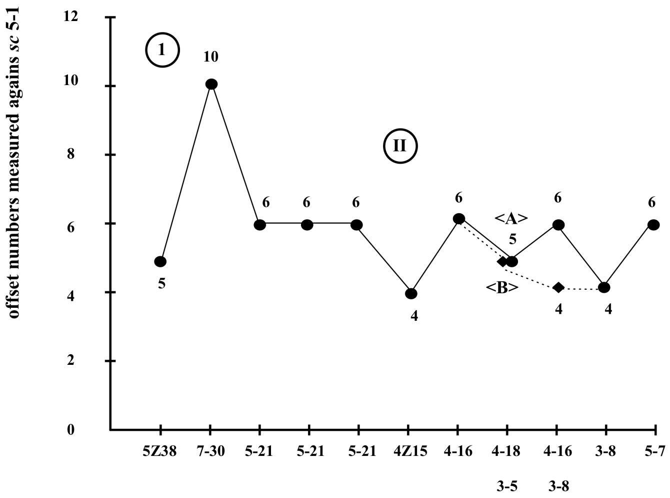
Graph 1 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7;
harmonic progression (solid line for progression A in Part II, and dashed for progression B)



Ex. 13 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7; piano part and its harmonic segmentation



Ex. 14 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7;
piano part and its voice-leading diagram



Graph 2 Webern, "*Die Geheimnisvolle Flöte*," op. 12/2, mm. 1–7, piano part; harmonic progression (solid line for progression A in Part II, and dashed for progression B)